Amendments to the Drawings:

The attached sheet of drawings includes changes to Figures 4A and 4B. This sheet, which includes Figures 4A-5, replaces the original sheet including Figures 4A-5.

Attachment: Replacement Sheet

REMARKS

Claims 1-19 are presented for further examination. Claims 1-3, 8-13, 15, and 16 have been amended.

In the Office Action mailed March 21, 2005, the Examiner objected to the drawings because Figure 4A was unclear and included the reference numeral "11" that was not in the specification, and Figure 4B contained the reference number "4.3" next to reference number 12.1 that should be "4.1." Applicants have corrected Figures 4A and 4B as noted by the Examiner. In addition the legend "Phim" has been changed to "Pim" to correspond to the text. No new matter has been added.

Claims 13, 18, and 19 were objected to because of informalities in that "an of" in claim 13, line 4 should be deleted, and in claims 18 and 19, line 1, the "fluid dynamic model" lacked proper antecedent basis. Applicants have amended claims 13 and 15 to overcome the informalities noted by the Examiner.

Claims 1 and 9 were rejected under 35 U.S.C. § 102(b) as anticipated by French Patent No. 2,808,051 ("Jens et al."). These claims were further rejected as anticipated European Patent No. 1,002,452 ("Sugiyama et al."), or U.S. Patent No. 6,311,669 ("Przymusinski et al."), or U.S. Patent No. 6,085,727 ("Nakano"). Claims 2-8 and 10-19 were rejected under 35 U.S.C. § 103(a) as unpatentable over any one of Jens et al., Sugiyama et al., Przymusinski et al., or Nakano in view of "Dynamic Modeling and Analysis of Automotive Multi-Port Electronic Fuel Delivery System" ("Yang et al.").

Applicants respectfully disagree with the bases for the rejections and request reconsideration and further examination of the claims.

Claim 1 is directed to a virtual pressure sensor for a Common Rail injection system of an endothermic engine, the injection system having at least one fuel pressure accumulating tank of the rail type with an input in fluid communication with a high-pressure pump and a plurality of outputs for feeding corresponding injectors, the sensor comprising a pressure regulating means connected to an electronic control unit that estimates fluid pressure in the accumulating tank and generates fluid pressure values, the pressure regulating means obtains the fluid pressure values and an injection law used by the electronic control unit, the pressure regulating means processing the fluid pressure values and the injection law in accordance with a

fluid-dynamic model for driving the injectors of the Common Rail injection system and to generate an estimated actual pressure value signal to the electronic control unit. Thus, the fluid-dynamic model is used to generate an estimated actual pressure value signal to the electronic control unit based on estimated fluid pressures in the accumulating tank and the injection law that is based on the estimated actual fluid pressure values at the fuel injectors themselves.

Jens et al., French Patent No. 2,808,051, teaches a pulsation model to estimate rail pressure. In contrast, the present invention uses a fluid-dynamic model and actual pressure values. In Jens et al., the injector opening duration is calculated to decrease the mass fuel injected as described at page 4. In the present invention, the rail pressure set by the electronic control unit is used in conjunction with the actual pressure value estimated by means of the fluid-dynamic model to control the opening duration of the injector only. In effect, due to the injector inertia, the opening duration is not proportional to the fuel injected. Thus, the claimed invention is more useful to maintain a constant pressure in the rail. Nowhere do Jens et al. teach or suggest a pressure regulating means cooperating with an electronic control unit and using a fluid-dynamic model to generate an estimated actual pressure value signal to the electronic control unit.

Sugiyama et al., European Patent No. 1,002,452, teaches at ¶¶ 13-15 a "fuel injection control amount" that is "based on a fuel injection timing of the injection means." In contrast, the claimed invention acts on the accumulating tank pressure set by the electronic control unit and uses the fluid-dynamic model as a pressure regulating means to supply a pressure value. Sugiyama et al. teach at ¶¶ 46-50 and in Figure 5 calculating a predictive rail pressure based on the fuel intake amount, temperature, engine rotational speed, injector pressure, and the volume elasticity coefficient of the fluid. In contrast, the present invention uses the fluid-dynamic model as recited in claim 1.

Przymusinski et al., U.S. Patent No. 6,085,669, relates to a method for determining the injection time in a direct-injection internal combustion engine. Przymusinski et al. teach using the equation of damped oscillation, which is in contrast to the present invention where a pressure regulating means in an accumulating tank of the rail type is connected to an electronic control unit that operates in accordance with a fluid-dynamic model. Thus, Przymusinski et al. do not relate to the Common Rail injection system of the present invention.

Nakano, U.S. Patent No. 6,085,727, is directed to a fuel injection method and apparatus for an engine that is based on the pressure of the working fluid in an accumulator as it is a function of the "detected" pressure at a constant sampling. In the present invention the working pressure is estimated by a fluid-dynamic model as recited in claim 1. Nakano controls the operating time duration of a control value for the working fluid in each injector. In contrast, the claimed invention controls the pressure regulator as it supplies information to the electronic control unit on the actual working fuel pressure, and based on this value the electronic control unit can set the pressure in the fuel accumulator. Thus, Nakano does not teach or suggest the combination recited in claim 1.

In view of the foregoing, applicants respectfully submit that claim 1 is clearly allowable over Jens et al., Sugiyama et al., Przymusinski et al., and Nakano.

Dependent claims 2-8 are allowable for the reasons why claim 1 is allowable as well as for the additional features recited therein. More particularly, claim 2 recites the fluid-dynamic model of the accumulating tank providing models of sections of the accumulating tank and sections corresponding to the injectors and generating the actual pressure signal in accordance with the equation as set forth therein. Nowhere do any of these references, taken alone or in any combination thereof with Yang et al., teach or suggest the equation set forth in claim 2. Yang et al., in particular, is a model that refers to a gasoline engine for maintaining a constant air/fuel ratio in the air intake pipe. In the present invention, there is no need to control an air/fuel ratio. In Yang et al., the injection occurs in the intake air stream (¶ 2, Figure 3). In the present invention the injection does not happen in the intake air pipe. Thus, the system of Yang et al. is clearly unrelated to the system of the present invention. Moreover, Yang et al. use the modal approximation technique to model the fluid system whereas in the present invention a complete fluid-dynamic equation is used. Thus, claims 2-8 are clearly allowable over the references cited and applied by the Examiner.

Independent claims 9, 12, and 15 each recite the use of the fluid-dynamic model for regulating pressure in an accumulating tank that, in cooperation with an electronic control unit, and that calculates an estimated actual pressure signal based on estimated pressure values and acquired fluid pressure values in the accumulating tank. Nowhere do Jens et al., Sugiyama et al., Przymusinski et al., or Nakano, taken alone or in any combination with Yang et al., teach

or suggest this aspect of the invention as recited in these claims. In view of the foregoing, applicants respectfully submit that claims 9, 12, and 15 are allowable for these reasons as well as for the reasons why claim 1 is allowable.

Claims 10-11, which depend from claim 9, claims 13 and 14, which depend from claim 12, and claims 16-19, which depend from claim 15, are allowable for the reasons why their respective independent claims are allowable as well as for the additional features recited therein.

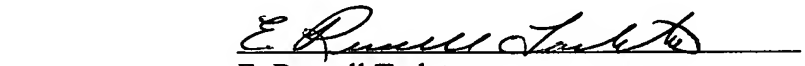
In view of the foregoing, applicants respectfully submit that all of the claims in this application are now in condition for allowance. In the event the Examiner finds minor informalities that can be resolved by telephone conference, the Examiner is urged to contact applicants' undersigned representative by telephone at (206) 622-4900 in order to expeditiously resolve prosecution of this application. Consequently, early and favorable action allowing these claims and passing this case to issuance is respectfully solicited.

The Director is authorized to charge any additional fees due by way of this Amendment, or credit any overpayment, to our Deposit Account No. 19-1090.

All of the claims remaining in the application are now clearly allowable. Favorable consideration and a Notice of Allowance are earnestly solicited.

Respectfully submitted,

SEED Intellectual Property Law Group PLLC



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ERT:alb

Enclosures:
Postcard
1 Sheet of Drawings (Figures 4A-5)

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